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TOBACCO SMOKE CONSTITUENTS: ARGUMENTATION

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I. INTRODUCTION

Tobacco smoke is a highly complex mixture containing, by some estimates, over four thousand constituents. Over the years, much time and effort has been devoted to determining the identity of tobacco smoke constituents. This has proven difficult, however, and much remains to be learned about the structure and makeup of tobacco smoke and its effects, if any, on human health. Although tobacco smoke constituents are among the most heavily researched substances in the world, no constituent as found in cigarette smoke (including "tar") has been scientifically proven to cause cancer or any other human disease.

Ninety percent of cigarette smoke is air, water and carbon dioxide, a natural by-product of combustion. Of the remaining ten percent, only a few substances such as nicotine and carbon monoxide (CO) have been measured by researchers as being present in smoke at levels above one milligram per cigarette. Anti-smoking advocates frequently assert that nicotine and CO cause disease in humans. The same is also said about "tar," even though it is a laboratory product and not an actual constituent of tobacco smoke.

The vast majority of the remaining chemical compounds actually present in cigarette smoke, some of which have been identified in "tar," are present only in extremely small amounts, mea-

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sured in micrograms (millionths of a gram) or nanograms (billionths of a gram) per cigarette. As is the case with "tar," nicotine and CO, these minute subfractions of tobacco smoke have not been proven to cause human disease as they are encountered by the human smoker.

Nonetheless, anti-smoking advocates occasionally single out for public criticism certain smoke constituents other than "tar," nicotine and CO, that have, under conditions and at levels vastly different from those to which a human smoker is exposed, been associated with disease in animals or humans. These substances, however, are ubiquitous. Smoker and non-smoker alike are exposed to most of these compounds each day simply by breathing air, drinking water and eating food.

The significance of smoke constituents to human health, if any, is not yet understood. However, "no ingredient (constituent) or group of ingredients (constituents) as found in tobacco smoke have been established as disease producing in smokers." (1)

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II. SMOKE CONSTITUENTS

A. "Tar"

"Tar" is not actually in tobacco smoke, although the many inaccurate references to "tar" in smoke may have created that impression. "Tar" is actually a laboratory product obtained by collecting the particulate matter in tobacco smoke, either by passing cigarette smoke through a cold trap at extremely low temperatures or by using filters and a drying process. However, material collected in this way does not duplicate what humans are exposed to when they smoke:

> "[T]here is, at present, no available instrumentation permitting the separation and individual collection of the particulate and gas phases which duplicates the precise physico-chemical conditions prevailing in cigarette smoke as it is inhaled." (2)

Despite its lack of relevance to smoking, laboratory-produced "tar" has been used in animal experiments designed to investigate the possible relationship between tobacco smoke and cancer. In those experiments, "tar" was repeatedly painted on the shaved backs or ears of test animals over prolonged periods of time. These so-called skin-painting experiments have prompted a great deal of interest, as the tumors which resulted have been

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said to be evidence that tumors might develop in human lungs from inhaling cigarette smoke.

The results of such animal experiments cannot and should not be extrapolated to the human situation. Even if the "tar" collected by the methods described above were present in cigarette smoke, the "tar" used in skin painting experiments is very different by the time it is studied in the laboratory. That is because after "tar" is collected, it continues to undergo chemical changes as long as it is stored. (3) The chemical and physical changes brought about in collecting "tar" and applying it to animals undoubtedly produce biological results quite different from any that may occur during inhalation. Furthermore, as an experimental toxicologist has noted, even if an effect such as tumor production is observed in a particular species, that does not necessarily mean that it might "occur either quantitatively or qualitatively in man." (4)

Skin painting experiments suffer from a number of additional weaknesses. For example, the concentrations of "tar" used in such experiments are extremely high. One researcher has estimated the amounts utilized to be equivalent to an individual smoking over 100,000 cigarettes per day. (5) Furthermore, the skin and ears of laboratory animals are not similar to human lung tissue. Animal skin lacks the intricate clearance mechanisms of the lungs,

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such as the mucus blanket which coats the lining of the major airways of the lung. Even the summary report of a study sponsored by the United States government utilizing skin painting techniques conceded that there is an "uncertain relationship between tumors resulting from mouse skin painted with condensate and human lung cancer." (7) Consequently, such experiments involve applying "the wrong material, in the wrong form, in the wrong concentration, to the wrong tissue of the wrong animal." (7)

It is misleading, therefore, to draw definitive conclusions about "tar" and human disease from skin painting studies. As a knowledgeable observer of research in this area has stated: "Bronchogenic carcinoma [lung cancer] has never been produced by tobacco or its products in any experimental animal despite the multiplicity of attempts." (8) All in all, the current state of scientific evidence concerning "tar" may be concisely summarized:

> "Human beings do not smoke 'tar' and laboratory reports on 'tar' yields have not been established as significant to human health." (9)

B. Nicotine

Nicotine is a natural element of tobacco and, thus, is present in tobacco smoke. Nicotine has been described as having no known chronic or cumulative effects on human health. (10) The

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data on the nature of nicotine's relationship to human health is inconclusive at best, because, among other things, science cannot determine with any precision how much nicotine a smoker is exposed to. In fact, no correlation between the nicotine level of a cigarette or the number of cigarettes smoked and the smoker's actual nicotine intake has been established because of individual variations in puff rates, depth of inhalation, and body metabolism. (11)

Nonetheless, anti-smoking advocates blame nicotine for the development of heart disease. Yet no mechanism by which nicotine, or any other agent, is involved in heart disease has been demonstrated. Serious questions about what role, if any, nicotine plays have been raised as a result of autopsy findings of fatty deposits and other changes in the arteries of individuals who either have not smoked or could have smoked only briefly, such as infants, children, and young men killed in battle. (12) Even the 1983 U.S. Surgeon General's Report, which focused on cardiovascular disease, concedes that "the evidence for and against a primary role for nicotine in the development or acceleration of atherosclerosis is not conclusive." (13) That opinion was shared by a German researcher who has conducted research on the relationship between nicotine and the clogging of arteries. After reviewing the literature, he and his co-author concluded that "there is no

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established evidence which supports the hypothesis that nicotine has any influence on the development" of those changes. (14)

The role of nicotine in the development of heart disease posited by anti-smoking advocates is further undermined by two epidemiological (population) studies. In a study that dealt with myocardial infarction (heart attack), the authors reported finding -- contrary to what they expected -- that the nicotine and carbon monoxide levels of the cigarettes smoked by their subjects were not related to the risk of heart attack. (15)

The second study, chaired by a well-known British scientist opposed to cigarette smoking, examined the serum (blood) levels of cotinine, a nicotine metabolite, in male nonsmokers and smokers of cigarettes only, cigars only, and pipes only. The study determined that the mean cotinine level for pipe smokers was significantly higher than the levels for cigarette and cigar smokers. Since studies of pipe smokers generally have not reported an increased risk of coronary heart disease, the researchers concluded that "nicotine is unlikely to be the major cause of the excess coronary heart disease mortality in cigarette smokers." (16) After re-evaluating their methodology in response to anti-smoking criticism of their study, the researchers again concluded, "we can be reasonably confident that exposure to high systemic concentrations of nicotine is not a cause of the disease." Although

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the researchers quibbled with the result of their own study, arguing that their data "cannot completely exonerate" nicotine, they added that the data do "substantially reduce the weight of evidence suggesting that nicotine is a cause of coronary heart disease." (17)

Animal studies which purport to establish a causal role for nicotine in heart disease have been soundly criticized for their unrealistic and excessive test conditions. An American researcher who conducted animal studies on this subject has noted:

> "There have been some studies that have exhibited minor or questionable changes with the use of 600 or more cigarettes a day in man. This is such a large number that I think man would find it difficult to find the time to smoke them." (18)

In contrast, animal studies using realistic doses of nicotine have "failed to initiate, exacerbate, or otherwise influence" the process leading to the clogging of arteries in test animals. (19) In one such study, which was funded by the United States government, male beagle dogs fed a special diet to induce this process were exposed for two years to cigarette smoke containing low or high levels of nicotine and, in some cases, enriched with CO. According to the final report of the research laboratory which conducted the study, "the results of this study lent no support to the suggestion that cigarette smoking increases the rate of development" of this process. (20)

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The foregoing demonstrates the validity of one researcher's summary: "While many studies have been done in this field, none have established nicotine as contributing to the causation, aggravation or precipitation of any cardiovascular disease." (21)

C. Carbon Monoxide

Carbon monoxide (CO) is a tasteless, odorless, colorless gas produced by many natural and man-made sources, including automobile exhaust and industrial emissions. Burning cigarettes also produce carbon monoxide, but that amount has been described as "insignificant" compared to most other sources. (22) It is also naturally produced during body metabolism. Nonetheless, CO has received considerable attention in the scientific literature, usually in regard to cardiovascular disease (CVD). In a review of such literature, however, two public health specialists concluded that "despite the large amount of literature available, the conclusions that can be drawn as to the role of CO in human CVD remain tentative and open to varying interpretations." (23) This conclusion is supported by a similar statement in the 1983 U.S. Surgeon General's Report, which focused on heart disease:

> "Carbon monoxide is another major component of cigarette smoke for which there are some data

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supporting a possible atherogenic [plaque forming inside the arteries] role; however, a review of recent literature on the role of carbon monoxide in arterial injury and atherogenesis leads to no consensus." (24)

The conclusion of another group which also reviewed the literature was more concise. The chairman of the American Heart Association Task Force on Environment and the Cardiovascular System reported that his group had concluded that the question of whether CO causes heart disease "remains unanswered even at the basic science level." (25)

Specialists who reviewed these and other studies have concluded that "there is no evidence" to support the suggestion that exposure to low or moderate levels of CO increases the rate of development of atherosclerotic disease in man. Indeed, they contend that "sufficient evidence is available" to support the conclusion that "CO is not of pathogenetic [disease causing] consequence in atherosclerotic disease." (26)

D. Other Constituents

Over the years, the principal focus of the attention and concern of smoking critics has been on "tar," nicotine and CO. One researcher who has tried to establish a causal link between

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smoking and disease, however, concluded with reference to these substances that:

> "We assume that it is the tar which causes lung cancer, but we do not know this for certain.
>
> Until now, we have implicated nicotine in the development of cardiovascular diseases, but we cannot prove this.
>
> The same is true for CO." (27)

Thus, some anti-smoking advocates have attempted to shift public attention to the presence of other substances in cigarette smoke. These substances, as found in cigarette smoke, have not been scientifically proven to cause any disease in humans, as is true with "tar," nicotine and CO. Nonetheless, these constituents are of interest because at levels and under conditions of exposure greatly different than those encountered by the smoker, certain of these compounds may have a toxic effect on or may be associated with disease in animals or humans.

It is an axiom among toxicologists that any substance is toxic if the level of exposure is high enough and no substance is toxic if the level of exposure is low enough. (28) The amount of substances other than nicotine and CO in cigarette smoke is extremely low, measured in terms of micrograms and nanograms per cigarette. As previously noted, a microgram is one-millionth of a gram, the equivalent of one second in twelve days. A nanogram is

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one billionth of a gram, the equivalent of one second in thirty-two years.

Moreover, these substances are for the most part natural by-products of combustion of any organic matter, including tobacco, or are found in any organic matter whether or not that matter is burned. Likewise, other compounds present in smoke are also present in the air we breathe and the water we drink. Thus, it is misleading and scientifically irresponsible to suggest that there is something "unique," and hence hazardous, about the presence of these substances in cigarette smoke.

-- Acetone

Acetone is present in minute quantities in the "vapor phase" of cigarette smoke, i.e., it is not found in "tar" (smoke condensate). It is most commonly encountered either at work or at home in the form of cleaning solvent. It has also been detected in freeze-dried foods and dried milk. Moreover, acetone is a naturally occurring constituent of human blood and urine. (29)

Acetone is not considered toxic at low levels of exposure, although at higher levels of exposure it can be an eye or skin irritant. One researcher was recently unable to produce tumors through the mouse-skin painting method with acetone. (30)

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-- Acrolein

Acrolein is present in small quantities in the vapor phase of cigarette smoke. It is also ubiquitous in the environment as a product of fires, automobile exhaust, and other industrial emissions. Acrolein is also produced by burning foods containing fat, such as grilling a steak. (31) Although at high concentrations acrolein may have a toxic or irritant effect, one recent review of the research conducted regarding acrolein's toxicity or carcinogenicity in humans concluded "there is no evidence to support that acrolein is a human carcinogen." (32)

-- Ammonia

Ammonia is detectable in minute amounts in cigarette smoke. It occurs naturally as a part of protein metabolism in man and in virtually all species of animals. Ammonia is widely used as a fertilizer. It is also a common household cleanser. (33) At high concentrations, ammonia can have a strong irritant effect and cause burns; its pungent odor, of course, is very familiar. One researcher, however, recently noted that:

> "The biologic significance of inhaled ammonia in the concentrations generated in mainstream smoke, which are very low, is purely conjectural." (34)

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-- Arsenic

Arsenic is a naturally occurring metal that is drawn into growing tobacco (and other plants) from the soil. It is present also in rocks, water, and virtually all living organisms in concentrations of parts per million and parts per billion. The United States government has estimated that non-smokers generally take in up to 60 micrograms of arsenic per day from various sources. The government also estimates that smokers take in an additional 2 micrograms of arsenic per pack of cigarettes smoked, thus increasing their daily arsenic intake only marginally. (35) One recent literature review noted that over 99% of the arsenic (and other metals such as lead and cadmium) in tobacco remains in cigarette ash. (36)

One reviewer of research attempting to demonstrate a relationship between exposure to arsenic and other metals and disease concluded that although arsenic has sometimes been indicated as a "possible" carcinogen in animal experiments, "none of [its] compounds has been proven capable of causing cancer." (37) This conclusion was recently echoed by another researcher, who characterized "the effect [of arsenic] on human smokers" as "speculative." (38) The 1982 U.S. Surgeon General's Report also noted that "the view that inorganic arsenics cause cancer of the skin and lung has not been widely accepted." (39)

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-- Benzene

Benzene has been reported to be present in the vapor phase of cigarette smoke in small quantities. Although benzene has sometimes been suggested as a possible cause of leukemia, leukemia has not been consistently related to cigarette smoking through the various statistical studies that form the primary basis for public health criticism of smoking. (40) The U.S. Surgeon General has also noted that "no dose-response relationship has been established between death rates from leukemia and the number of cigarettes smoked." (41)

-- Benzo(a)pyrene

Benzo(a)pyrene (BaP) is sometimes singled out as a possible human carcinogen because it is a component of the laboratory product "tar;" "tar," as noted above, can produce tumors under the highly artificial conditions involved in animal skin painting experiments. Claims that BaP, and other polycyclic aromatic hydrocarbons (such as dibenzacridine), can cause cancer in humans thus suffer from the same weaknesses as those claims generally directed at "tar."

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BaP is formed by the incomplete combustion of organic matter. In addition to cigarette smoke, other sources of BaP in the atmosphere are coal and oil fired power stations, domestic heating, industrial processes and emissions, automobile emissions, and forest fires and volcanic activity. Atmospheric BaP is carried into the soil, the water table, and the ocean through rainfall. Thus, BaP is detectable in fish, meat and vegetables, as well as in tap water. Foodstuffs as varied as coconut oil, sardines, and cheese all contain BaP at relatively high levels. Charcoal-grilled meats have been found to contain particularly high levels of BaP. (42) Two researchers concluded that the BaP concentration in a single charcoal-grilled steak was equivalent to that in the smoke of 600 cigarettes. (43) The daily levels of exposure to BaP simply from breathing the air in some cities has been estimated, by a former U.S. Surgeon General, to be approximately twice as high as that for a cigarette smoker. (44)

-- Butane

Butane may be present in the vapor phase of cigarette smoke in minute quantities. It occurs in natural gas and is present in the atmosphere as the result of the combustion of gasoline and other petroleum products. Butane is also frequently used as an aerosol propellant. The inhalation of butane has not been demonstrated to have chronic health effects in humans. (45)

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-- Cadmium

Cadmium is a trace "heavy metal" present in tobacco and in cigarette smoke in certain compound forms. It is used extensively in the production of cadmium-copper alloys and corrosion-resistant coatings. It is found in alkaline batteries, glass, solder, paint pigments and some pesticides and fungicides. The principal source of cadmium exposure for man is in food, dairy products and drinking water.

It has been estimated that in most countries the average smoker is exposed to approximately the same amount of cadmium daily through smoking as he or she is through diet. (46) Another researcher recently concluded that the amount of cadmium in two packs of cigarettes, even if entirely inhaled, would still be less than would be inspired in two hours of breathing atmospheric cadmium at the maximum safe levels established by a number of countries' health authorities. (47)

Cadmium has been identified as a possible tumor promotor under experimental conditions in animals. Three German researchers recently observed, however, that the results of these experiments should not be extrapolated to humans because the doses necessary to induce tumor production corresponded to between five thousand

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to twenty thousand cigarettes smoked per day. (48) Similarly, a recent review of the literature concerning the claimed carcinogenicity of cadmium noted that "evidence for potential cadmium carcinogenicity in humans in the dosage delivered from smoking is very limited." (49)

-- Hydrogen Cyanide

Hydrogen cyanide (HCN) is present as a component of the vapor phase of cigarette smoke in minute amounts. It is produced by the combustion of the amino acids in tobacco. HCN is also generated by the combustion of carbon materials in air, for example, during home cooking. HCN is used in a variety of industrial processes and is also present in such varied food products as bitter almonds, lima beans, soybeans, apricots, cassava and linseed. It has been detected in certain wines. (50)

A recent study noted that although the cyanide level detectable in smokers' blood is slightly elevated after smoking, it is rapidly eliminated from the system. (51) Another reviewer concluded that the effect of HCN in cigarette smoke, if any, on humans "remains to be determined." (52)

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-- Lead

Lead, like the other trace metals present in tobacco, is drawn from the soil into the growing plant. Also like the other trace metals, it is estimated that something less than one percent of the lead in the tobacco is transferred to the smoke, with the remainder left in the ash. (53) Lead is present in the air, soil and water. Hence, smokers and non-smokers alike are exposed to and ingest small amounts of lead each day. One research group has estimated that a smoker will ingest five nanograms of lead from a pack of cigarettes; the dietary intake of lead per day, however, is much higher, ranging between 100-500 nanograms per day. (54)

Numerous health concerns have been expressed regarding exposure to high levels of lead and lead compounds. However, given the very low levels of lead exposure from tobacco, "the role of lead as a potential carcinogen for human smokers is not known." (55)

-- Methanol

Methanol is present in very small quantities in cigarette smoke as a vapor phase component. It is used in enamels, dyes, stains, cleaning solvents, paint and varnish removers, antifreeze

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mixtures, and as fuel for internal combustion engines. It is also present in bread, soy sauce and various fruits and vegetables. (56)

Methanol can be a skin and eye irritant in large concentrations. One researcher recently noted, however, that "[c]onsidering the dose of methanol estimated to be toxic to humans (1 g/kg), it is unlikely that a normal human being could ever be exposed to enough of it by inhalation to experience acute toxicity." (57) This scientist also noted that he had been unable to find any studies showing the inhalation of methanol to be carcinogenic.

-- Naphthalene

Naphthalene is a substance related to benzene. It is present both in "tar" and in the vapor phase of cigarette smoke in small quantities, and is generated by the combustion of tobacco. Naphthalene is used extensively in the chemical, plastics and dye industries. In the home, it is found frequently in air fresheners, moth balls, varnishes and wood preservatives. Radishes also contain naphthalene. Naphthalene has no reported carcinogenic effect, although it is sometimes associated with leukemia in animal experiments. As noted above, leukemia has not been consistently statistically associated with cigarette smoking. (58)

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-- Nickel

Nickel, like arsenic, is drawn from the soil into growing tobacco. Also like arsenic, it is estimated that 99% of the nickel in tobacco remains in the ash of a cigarette, and is not transferred to the smoke. The U.S. Surgeon General has concluded that "it is not likely that nickel plays a significant role in the etiology of lung cancer in cigarette smokers." (59) Other researchers and reviewers have reached the same conclusion. (60)

-- Nitrogen Oxides

Cigarette smoke may contain trace amounts of nitrous oxide, nitric oxide and nitrogen dioxide. The amounts are so low, however, as to be nearly undetectable. The U.S. Surgeon General has concluded that the nitrogen oxides in cigarette smoke have no toxic or negative pulmonary effects on smokers. (61)

-- Nitrosamines

Nitrosamines are detectable in both "tar" and in the vapor phase component of cigarette smoke. The presence of nitrosamines in cigarette smoke is often the subject of public comment by anti-smoking advocates because, under experimental conditions, certain nitrosamine compounds can produce tumors in laboratory

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animals. As one reviewer of the literature noted, however, "evidence that would associate nitrosamines with human cancer is very limited." (62) Another recent reviewer opined that:

> "The role of nitrosamines in the pathogenesis of human lung cancers is theoretical, and it is yet to be shown conclusively that any specific N-nitroso compound causes human cancer." (63)

The U.S. Surgeon General also determined that there is no conclusive evidence that the nitrosamines specific to tobacco had any proven health effect on smokers. (64)

The components of nitrosamines -- nitrates, nitrites and amines -- are naturally occurring substances. Hence, nitrosamines are found in soil, air, water and food. Beer and scotch whiskey have recently been determined to contain dimethylnitrosamine. (65) Foods often prepared with nitrites (used as a preservative) include ham, sausages, bacon, luncheon meats and frankfurters; seafood and cheese also often contain nitrosamines. (66)

-- Phenol

Phenol is present in minute quantities in cigarette smoke and is detectable in "tar." It has a variety of industrial uses, including the manufacture of perfumes, plastics and fertilizers. Phenol occurs naturally in animal tissues; the consumption of meat

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has been identified as the primary source of human exposure to phenol. It is also present in tap water. (67) One reviewer of the literature concluded that "[t]here is no specific evidence of human cancer attributable to phenol or related compounds." (68) A researcher likewise reported that phenol is not present in cigarette smoke at high enough concentrations to have any demonstrated health effects on smokers. (69)

-- Polonium-210

Polonium-210 is a radioactive element present in trace amounts in tobacco and cigarette smoke. It is also present in the atmosphere and in soil -- both as a part of the earth's natural background radiation and as a result of nuclear testing -- from which it is presumably drawn into growing tobacco. Smoking critics often cite the presence of polonium-210 in smoke as significant because it, along with most other radioactive materials, can have adverse health effects in humans and in animals if the exposure is of sufficient intensity. The U.S. Surgeon General, however, has repeatedly questioned the significance of polonium-210 to lung cancer in humans. (70) Other researchers have disputed the conclusion drawn by some scientists that polonium-210 accumulates in the lung tissue of smokers. (71) Additional researchers discount the claimed risk to smokers of inhaled polonium, noting the extraordinarily minute quantities at which it is present. (72)

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-- Toluene

Toluene is a constituent of the vapor phase component of cigarette smoke. It is present in the atmosphere as a result of industrial emissions, automobile emissions, and gasoline evaporation. Exposures at home include inks, dyes, and perfumes. (73) At low levels and concentrations, toluene has reportedly not been found to be toxic or to cause chronic disease in humans, although it is an eye and skin irritant. (74)

-- Urethane

Urethane (ethyl carbamate) is present in cigarette smoke in very small amounts. It has been widely used in the plastics and textile industries. It is also used in a variety of agricultural chemicals, pesticides, fungicides, and in some therapeutic drugs. Urethane is a natural by-product of fermentation, and is found in wines, distilled spirits, and beer, as well as in fermented food products such as cheese, yogurt and soy sauce. (75) The U.S. Surgeon General has conceded that urethane, although possibly an animal carcinogen, is not present in cigarette smoke in sufficient quantities to pose a health risk to smokers. (76)

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-- Vinyl Chloride

Vinyl chloride is present in minute amounts in the vapor phase of cigarette smoke. Although it is a gas, it is detectable in various food products such as honey, butter, ketchup and syrup. It is also present in some wines. (77) Vinyl chloride is also used in the manufacture of plastics. (78) Vinyl chloride has been reported to have toxic and carcinogenic effects in animals at high concentrations; a similar effect on humans has been suggested. One group of oncologists, however, although subscribing to the general theory that smoking causes cancer, conceded that:

> "Based on human data and results from animal studies, it appears that the[] minute amounts of [vinyl chloride in cigarette smoke] will not contribute to a measurable degree to the carcinogenic activity of tobacco smoke." (79)

This conclusion was echoed by a recent literature reviewer, who concluded that vinyl chloride is present in cigarette smoke "apparently at levels too low to be considered a carcinogen or fibrosis-inducing agent." (80)

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III. CONCLUSION

Numerous claims have been made about the relationship between cigarette smoke constituents and the health of the smoker. However, such claims are just that -- claims which are not supported by reliable scientific proof. After years of study, no scientific relationship has been established between "tar," carbon monoxide, nicotine and adverse health effects. Other chemical compounds, detectable at extremely low levels in cigarette smoke, are the subject of occasional public comment. These compounds are not unique to tobacco smoke, however, and as with "tar," nicotine and CO, have not been shown to be hazardous to humans as found in cigarette smoke.

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